

H 49 AE: corn hybrid for the High Valleys of Mexico with androsterility for seed production

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Abstract

In Mexico, corn (*Zea mays* L.) is the most important crop due to its sown area, its consumption of more than 200 kg per person per year, as well as due to the role it plays in the economy. Every year more than 12 million tonnes of corn are imported, so it is urgent to increase grain production, for this, improved varieties with good productivity are required, such as the H 49 AE hybrid, which was generated in the Corn Genetic Improvement Program of the National Institute of Forestry, Agricultural and Livestock Research based in the Valle de México Experimental Field, the H 49 AE hybrid, with androsterility in its progenitors, solves the problem present in the production of hybrid corn seed, since it limits the detasseling, which favors maintaining the genetic quality of the seed; saves from 24 to 50 daily wages ha⁻¹, work that causes economic losses in seed companies and waste of registered seed, in addition to limited grain production, for not using the best hybrid corns. The average yield of H 49 AE, in the validation, in the State of Mexico was 10 700 kg ha⁻¹, with a variation from 8.5 to 12.5 t ha⁻¹. On average the behavior is higher by 23.7% with respect to the control hybrid 'H-48'.

Keywords: *Zea mays* L., androsterility, hybrids, yield.

Reception date: August 2022

Acceptance date: September 2022

In Mexico, every year 12 million tonnes of corn grain (*Zea mays* L.) are imported, Turrent (2009), so it is urgent to increase production and have varieties that have greater productivity. In the High Valleys of Mexico, located at more than 2 200 masl, 2 million ha of corn were harvested in 2014, obtaining an average yield of 2.82 t ha⁻¹ (Virgen-Vargas *et al.*, 2016). With the application of technological recommendations and a greater use of improved varieties, corn yields could be raised, in 300 000 ha of the High Valleys, with residual moisture, irrigation tip and good rainy season, where the average yield is 3.5 t ha⁻¹ of corn grain, high-yield hybrids could be sown to exceed the yield, taking it to 6 t ha⁻¹ (Tadeo-Robledo *et al.*, 2016; Martínez-Gutiérrez *et al.*, 2018).

An alternative to facilitate seed production and raise the level of adoption of corn hybrids in the High Valleys is the use of gene-cytoplasmic androsterility in progenitor lines of hybrids, which eliminates the need to detassel (Martínez-Lázaro *et al.*, 2005). Since 1992, researchers from the National Institute of Forestry, Agricultural and Livestock Research (INIFAP, for its acronym in Spanish) and the National Autonomous University of Mexico (UNAM, for its acronym in Spanish) have worked with sources of male sterility, in its incorporation into the progenitors of hybrids already existing and in the process of development (Tadeo-Robledo *et al.*, 2016; Espinosa-Calderón *et al.*, 2018). As a result of these works, the H 49 AE corn hybrid was formed.

This hybrid was registered in the National Catalog of Plant Varieties (CNVV, for its acronym in Spanish), obtaining the definitive registration MAZ-1675-181115, in 2015, it was also registered with UPOV, on June 23, 2016, with the breeder's title number 1 534, in favor of INIFAP. The H-49 AE, a three-line hybrid, has wide adaptability and can be sown at altitudes from 2 000 to 2 600 m, where the hybrids H-50 and H-48 thrive, in localities of the State of Mexico, as well as in the states of Puebla, Hidalgo, Michoacán and Querétaro (Espinosa *et al.*, 2003).

It complies with the commercial and industrial parameters for the preparation of tortillas by the traditional method, nixtamal-dough-tortilla. H 49 AE is a trilinear hybrid, with white and semi-toothed grain, with adaptation to the High Valleys. It is of intermediate cycle, its male flowering (tassel) appears at 88 days and the female flowering (ear) at 89 days, at altitudes of 2 250 m. It reaches physiological maturity at 163-165 days (Figure1).



Figure 1. Plant and ear appearance of the H-49 AE corn hybrid.

It can be cut, stacked and then harvested, if this work is done manually; but with machinery, it can be cut at 177 days, with mechanical harvester. Its potential yield is 12.5 t ha^{-1} . The relevance of the technology in the H 49 AE hybrid lies in the fact that androsterility was incorporated in its progenitors to facilitate the production of seeds, which favors maintaining genetic quality and supports the supply of seeds, by seed companies and groups of producers (Tadeo *et al.*, 2013).

The average yield of H 49 AE, in the validation in the State of Mexico, was $10\,700 \text{ kg ha}^{-1}$, with a variation from 8.5 to 12.5 t ha^{-1} . On average, the behavior was higher than 23.7% with respect to the control hybrid 'H-48'. The use of H 49 AE benefits commercial corn producers and there is certainty in seed quality. It is an alternative to the hybrids H-48 and H-50, which have already been on the market for 20 years (Espinosa *et al.*, 2003).

The structure of the hybrid is (M56AE x M57) x M58, in its androsterile version and (M56F x M57) x M58, in the androfertile version. M56F was obtained from CIMMYT germplasm, from selections in self-fertilization, plant-to-plant, full-sibling crosses, fraternal and self-fertilization cycles, until locating the M56F line, the M56AE line was developed at UNAM-INIFAP, by incorporating into the M56F line the C-type gene-cytoplasmic androsterility, identified at UNAM with genealogy CxP3PL7, characterized by its stability and action in group C (Canales *et al.*, 2017).

The M56F line was used as a male progenitor to cross with the androsterility source, later, six backcrosses to the M56F line were made to develop the male sterility version of the M56 AE line, which is considered an isogenic version, whose maintainer is the M56F line itself in its fertile version. M57 is a line that was derived from CIMMYT germplasm. It is of the Cónico race with influence of the Celaya race, obtained from two cycles of full siblings, as well as seven cycles of self-fertilization and then fraternal increases. M58 is a line, derived in the INIFAP, from the F2 generation of a commercial material of the High Valleys and advanced for five cycles of self-fertilization and then fraternal increases.

To ensure the genetic purity of H-49 AE, the seed of this trilinear hybrid and its progenitors (three lines, single cross and trilinear hybrid); that is, the high-register categories, these materials must be increased in lots isolated from other lands sown with corn, separated at least 300 m for basic (lines) and registered (single cross) seeds and 200 m to multiply certified seeds.

Another option is to isolate by time with a difference of 20 days, in the date of sowing with respect to other neighboring corns, so that there is no coincidence of the flowering of a lot of production of H-49 AE seed with other nearby lots. Off-type or diseased plants should be removed at least in three stages, at 25 days, 50 days and before flowering (pollen release).

At the time of harvest, the quality of the seed batch can still be improved by removing off-type, malformed ears or with some degree of rot or with holes. For the refreshment and maintenance of the original seed, of the H-49 AE hybrid, the M56F line must be increased by self-fertilization. The M56 AE line is androsterile and preserves its identity by combining with the M56F line, which is

its fertile maintainer. On the other hand, for lines M57 and M58, it is necessary to increase them in a fraternal or chain way. The female single cross, androsterile version of the trilinear hybrid preserves its varietal identity by crossing the lines M56AE x M57, in a similar way, the female single cross, in fertile version of the trilinear hybrid, preserves its varietal identity by crossing the lines M56F x M57.

The trilinear hybrid in the field is obtained using the conformation (M56AE x M57) x M58. Since the resulting seed is androsterile, because M58 has no restorative capacity, the conformation (M56F x M57) x M58 must also be increased, the previous conformations must be carried out in a proportion of 80%: 20%, which ensures that proportion of androsterile and fertile seed in the commercial hybrid H-49 AE in farmers' lands.

The above is achieved by establishing this proportion in the field, in which the fertile fraction is manually detasseled, reviewing the androsterile fraction to ensure that there are no plants releasing pollen, at harvest, ears of androsterile and fertile females are mixed to obtain the indicated 80:20 ratio (Espinosa-Calderón *et al.*, 2009; Espinosa-Calderón *et al.*, 2018).

Agronomic practices to preserve the characteristics that identify the hybrid must adhere to the recommendations for producing seed of this type of hybrids, unmix three times and adhere to the description. The size of the population for increase of each line is sufficient with a minimum of 100 plants per increase, to preserve the characteristics that identify each line. For hybrid seed production, the number of generations must be limited to the four established, basic for the M58 line and registered for single crossing (M56AE X M57) and (M56F X M57).

The seed of H-49 AE can be produced in the spring-summer agricultural cycle, in the Valley of Mexico, in localities such as Cuautitlán Izcalli, Texcoco, Zumpango, Tlaxcala, at altitudes ranging from 2 100 to 2 650 m. An advantage in the production of H-49 AE seed is that the sowing between the female single crosses (androsterile and fertile) are carried out simultaneously with the male line M58, since there is complete coincidence to flowering of the stigmas of the female single crosses, with the release of pollen of the male line M58.

Although the source line of androsterility has shown stability in its expression in sowings carried out from sea level to 2 650 masl [in the Cotaxtla and Iguala Experimental Fields of INIFAP, Tlaltizapán Field of the International Maize and Wheat Improvement Center (CIMMYT, for its acronym in Spanish) and Toluca Site Experimental Field], mechanical contaminations or volunteer plants could occur, so it will always be better to check the production lots to maintain genetic quality.

At harvest, ears of androsterile and fertile females are mixed to obtain the indicated 80:20 ratio (Tadeo-Robledo *et al.*, 2018). Seed production can be done in the spring-summer agricultural cycle in the Valley of Mexico, in localities such as Cuautitlán Izcalli, Texcoco or Zumpango, in other regions such as the Toluca-Atlacomulco Valley, as well as in the Puebla Valley, or localities in the state of Tlaxcala, at altitudes ranging from 2 100 to 2 650 m.

Conclusions

The registered seed of the female and basic single crosses of the male line can be acquired in the Valle de México Experimental Field, to increase certified seed under the supervision of the National Seed Inspection and Certification Service (SNICS, for its acronym in Spanish).

Acknowledgements

This research was part of the program to support research and technological innovation projects. PAPIIT: IT201618. Cuautitlán Faculty of Higher Studies-UNAM.

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